Before the
FEDERAL COMMUNICATIONS COMMISSION
Washington, D.C. 20554

In the Matter of	)	
	)	
Expanding Flexible Use in Mid-Band Spectrum Between 3.7 and 24 GHz	)	GN Docket No. 17-183
	)	

REPLY COMMENTS OF THE SATELLITE INDUSTRY ASSOCIATION

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SUMMARY

To borrow a phrase from Mark Twain, reports of the death of C-band satellite service are greatly exaggerated. The record here contains ample evidence that C-band fixed-satellite service ("FSS") networks provide services essential to the overall communications infrastructure, ranging from their pivotal role in delivering video and audio programming enjoyed by virtually all U.S. consumers to their use for lifeline connectivity in areas that lack any terrestrial alternatives. By themselves, C-band space and earth stations represent an investment of billions of dollars, and they support other industries that are major contributors to the country's economy, as well as government agency operations critical to national security and public safety. To maintain these integral and necessary services, the Commission must maintain policies that enable flexible, efficient, high-quality satellite offerings in response to customer demand.

Certain terrestrial interests ignore the record evidence and attempt to perpetuate several myths regarding the intensity and importance of satellites' use of C-band spectrum, particularly with respect to the 3.7-4.2 GHz downlink portion. The Commission must not be swayed by these exercises in wishful thinking.

First, there is the pervasive myth that C-band spectrum is currently underutilized. Nothing could be further from the truth. Dozens of C-band satellites serve the U.S. today, and new spacecraft are being deployed to meet ongoing demand. These satellites communicate with a widely-dispersed population of earth stations, the vast majority of which – perhaps 90% – are unregistered, a ratio that suggests that total receive earth station numbers may be in the tens of thousands.

Terrestrial interests that cite earth station application data to suggest that FSS use of C-band spectrum is declining fail to acknowledge that the antennas listed in the Commission's

IBFS database represent the tip of a very large iceberg given the huge numbers of unregistered receive-only facilities. Some commenters compound the error by highlighting the fact that no C-band earth station renewal applications have been filed in recent years, ignoring a Commission decision extending earth station license periods that led to a five-year period beginning in 2012 in which no earth station licenses – in any band – were eligible for renewal.

Thus, attempts to downplay the extent or importance of C-band satellite services must be rejected. The record amply shows that C-band satellites are an integral part of the nation's communications architecture, directly communicating with tens of thousands of earth stations and indirectly serving more than 100 million U.S. television households, tens of millions of terrestrial and satellite radio listeners, and hundreds of thousands of residents of remote and rural locations beyond the reach of terrestrial infrastructure.

A second and related myth is the suggestion of a "quick fix" – the idea that C-band FSS services can easily be replaced by shifting them to higher-frequency satellites, to fiber, or to some other alternative. In evaluating these claims, the Commission should be guided by a simple adage: if it sounds too good to be true, it probably is. Parties that assume Ku- or Ka-band satellites can take on the full load carried by the dozens of C-band spacecraft currently serving the U.S. ignore the fact that these higher-frequency satellites are already in use, with very limited available capacity remaining. Even if capacity were available, though, these higher-frequency satellites cannot match C-band's resistance to atmospheric attenuation – a critical factor for content distributors that rely on C-band satellites' reliability.

Similarly, parties that point to fiber as an alternative to C-band FSS are silent on the consequences of such a shift for the many broadcasters and cable systems in markets where fiber is not available – the smaller communities and rural areas that depend most on C-band satellite

service. Consumers in these areas would bear the brunt of any mandated change to fiber, losing access to the wide range of programming and advanced video services they receive through C-band FSS distribution networks today. Even in areas where fiber is available, the cost to the program distributors and their customers of replacing their current terrestrial earth station infrastructure with fiber connectivity would be significant.

Attempting to impose co-frequency, co-coverage sharing between satellite services and new terrestrial operations would clearly fail to achieve its intended effect. Preventing interference to thousands of receive earth stations that require the flexibility to operate with multiple satellites across the C-band spectrum would require substantial separation distances, leaving limited or no opportunity for terrestrial deployment in much of the country. Moreover, the fact that the overwhelming majority of earth stations are unregistered makes Commission forced implementation of such separation distances impractical.

Assertions that a database approach could make sharing possible are similarly flawed. Database technology adopted for the 3.6 GHz band has not yet been tested for its ability to manage interference to the small number of earth stations using that band, and certainly cannot be presumed to be reliable for protection of the exponentially greater number of conventional C-band earth stations. Similarly, no party attempts to explain how a database can effectively protect FSS receive earth stations without access to information regarding the locations of the thousands of those earth stations that are unregistered or how such a system would protect satellite earth stations from possible mobile terrestrial use.

In short, the Commission should critically examine the claims of any party promising an easy solution that allows new terrestrial use of C-band spectrum while preserving the essential services C-band satellites provide. Forcing FSS out of the C-band would result in widespread

disruption of the existing infrastructure and a loss of video service to large numbers of U.S. consumers, particularly in more rural areas. And given the broad FSS use of C-band spectrum and the sensitivity of earth station receivers, attempting to shoehorn in new C-band terrestrial services through a co-frequency, co-coverage database approach is unlikely to succeed.

Finally, there is the "everyone is doing it" myth – the idea that there is a global movement towards permitting terrestrial mobile operations in the 3.7-4.2 GHz band and that U.S. acquiescence to this trend will foster global spectrum harmonization. Although a few countries are pursuing some spectrum in the 3.7-4.2 GHz range for terrestrial mobile systems, most are not.

For the C-band uplink frequency segments in the 5.925-7.125 GHz range that are discussed in the Notice, the prospects for successful sharing are murky as well, especially if the Commission pursues the introduction of unlicensed terrestrial devices in this spectrum. In particular, no party has put forth a reliable means to ensure that receivers onboard satellites are protected from unacceptable aggregate interference that could result if such devices proliferate.

SIA supports the Commission's commitment to exploring ways to enable innovation and U.S. leadership by making additional spectrum available for next-generation wireless broadband networks. But established, vitally important C-band satellite services that benefit every American must not be sacrificed in that effort. Instead, the Commission must ensure that satellite operators and their customers have access to C-band frequencies and can continue to take advantage of the nationwide coverage and outstanding performance possible in this critical satellite spectrum without risk of interference from additional terrestrial services.

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REPLY COMMENTS OF THE SATELLITE INDUSTRY ASSOCIATION

The Satellite Industry Association ("SIA")[1] hereby replies to the comments of other parties in response to the Commission's Notice of Inquiry in the above-captioned proceeding, which seeks input regarding whether new terrestrial wireless services can feasibly be introduced in spectrum bands between 3.7 GHz and 24 GHz, including C-band frequencies heavily used for fixed-satellite service ("FSS") networks.[2] As discussed herein, the record before the Commission confirms the critical importance of C-band satellite services and highlights the need to preserve and protect satellite access to this core FSS spectrum.

BACKGROUND AND INTRODUCTION

The initial SIA Comments recount in detail the often unappreciated but nevertheless essential role that C-band satellites play in supplying content and connectivity to U.S. consumers

[1] SIA Executive Members include: The Boeing Company; AT&T Services, Inc.; EchoStar Corporation; Intelsat S.A.; Iridium Communications Inc.; Kratos Defense & Security Solutions; Ligado Networks; Lockheed Martin Corporation; Northrop Grumman Corporation; OneWeb; SES Americom, Inc.; Space Exploration Technologies Corp.; SSL; and ViaSat, Inc. SIA Associate Members include: ABS US Corp.; Analytic Graphics Inc; Artel, LLC; Blue Origin: DigitalGlobe Inc.; DataPath Inc.; DRS Technologies, Inc.; Eutelsat America Corp.; Global Eagle Entertainment; Globecomm; Glowlink Communications Technology, Inc.; Hawkeye360; Hughes; Inmarsat, Inc.; Kymeta Corporation; L-3 Electron Technologies, Inc.; O3b Limited; Panasonic Avionics Corporation; Planet; Semper Fortis Solutions; Spire Global Inc.; TeleCommunication Systems, Inc.; Telesat Canada; TrustComm, Inc.; Ultisat, Inc.; and XTAR, LLC. For more information, visit www.sia.org. These comments are supported by all SIA members except for Ligado and AT&T, which abstain from participation.

[2] *Expanding Flexible Use in Mid-Band Spectrum Between 3.7 and 24 GHz*, Notice of Inquiry, GN Docket No. 17-183 (rel. Aug. 3, 2017) (the "NOI").

nationwide.[3] These core assets form the backbone for video and audio programming contribution and distribution, serve as the sole form of interconnection for residents of remote areas, are relied on by government agencies for key national security and public safety operations, deliver emergency information, restore service when terrestrial networks are damaged, and enable communication with naval and commercial ships at sea.[4]

Attempting to introduce new terrestrial operations into the existing environment on a co-frequency, co-coverage basis could pose a grave threat to C-band FSS. In particular, the tens of thousands of earth stations receiving in the 3.7-4.2 GHz band, most of which are unregistered, are highly sensitive to terrestrial interference. As a result, co-frequency, co-coverage FSS sharing with terrestrial mobile networks, including through the use of a database approach, is fundamentally infeasible.[5] Technical challenges also constrain the ability to prevent interference to receivers on satellites if unlicensed devices are permitted to use C-band uplink spectrum in the 6 GHz band.[6]

Numerous other commenters echo these concerns, highlighting their own dependence on the extremely-reliable C-band FSS architecture to deliver content to televisions and radios

[3] Comments of the Satellite Industry Association, GN Docket No. 17-183, filed Oct. 2, 2017 ("SIA Comments").

[4] *Id.* at 5-16.

[5] *Id.* at 34-41.

[6] *Id.* at 41-44.

nationwide,[7] re-establish communications links when terrestrial systems are damaged,[8] supply lifeline connections to the public switched telephone network for residents of Alaskan bush villages,[9] distribute emergency alerts,[10] and support air traffic control and other essential public safety and national security systems.[11] In addition, there is a broad recognition of the significant technical obstacles to introducing new co-frequency, co-coverage terrestrial operations in C-band spectrum given the intensive use of the frequencies for FSS operations.[12]

Indeed, even commenters with a strong interest in terrestrial wireless services emphasize that the Commission must proceed with extreme care and avoid disrupting essential satellite services. AT&T, for example, "cautions that there are significant challenges inherent in reallocation or sharing of the candidate bands identified by the Commission."[13] Similarly,

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[7] *See e.g.*, Comments of the American Cable Association, GN Docket No. 17-183, filed Oct. 2, 2017 ("ACA Comments") at 2; Comments of the Content Companies (the Walt Disney Company, CBS Corporation, Scripps Networks Interactive, Inc., Time Warner Inc., 21st Century Fox, Inc., and Viacom Inc.), GN Docket No. 17-183, filed Oct. 2, 2017 ("Content Company Comments") at 1; Comments of iHeartMedia + Entertainment, Inc., GN Docket No. 17-183, filed Oct. 2, 2017 ("iHeartMedia Comments") at 1-2; Comments of the National Association of Broadcasters, GN Docket No. 17-183, filed Oct. 2, 2017 ("NAB Comments") at 2; Comments of NCTA – The Internet & Television Association, GN Docket No. 17-183, filed Oct. 2, 2017 ("NCTA Comments") at 3; Comments of SES Americom, Inc., GN Docket No. 17-183, filed Oct. 2, 2017 ("SES Comments") at 2-3; Comments of Sirius XM Radio Inc., GN Docket No. 17-183, filed Oct. 2, 2017 ("Sirius XM Comments") at 5-6.

[8] Comments of AT&T Services, Inc., GN Docket No. 17-183, filed Oct. 2, 2017 ("AT&T Comments") at 8.

[9] *See id.* at 9; Comments of General Communication, Inc., GN Docket No. 17-183, filed Oct. 2, 2017 ("GCI Comments") at 2-3.

[10] Comments of National Public Radio, Inc., GN Docket No. 17-183, filed Oct. 2, 2017 ("NPR Comments") at 9; Sirius XM Comments at 8; iHeartMedia Comments at 2.

[11] *See, e.g.,* Reply Comments of Aviation Spectrum Resources Inc., GN Docket No. 17-183, filed Oct. 3, 2017 ("ASRI Reply") at 2.

[12] *See, e.g.,* ACA Comments at 2-3; Content Company Comments at 6-7; iHeartMedia Comments at 1; NAB Comments at 6-8; Sirius XM Comments at 9-11.

[13] AT&T Comments at 4.

NCTA "urges the Commission to ensure that C-band transmissions carrying millions of hours of content to thousands of cable headends are fully protected from harmful interference," emphasizing that the Commission should authorize new uses of C-band spectrum only "if it has before it a complete record . . . demonstrating that new users can fully protect existing operations."[14]

SIA urges the Commission to heed these warnings. Attempts by terrestrial interests to imply that FSS use of C-band is declining conflict with the incontrovertible facts. Indeed, SIA has previously and extensively debunked these claims in its pleadings earlier this year addressing requests for fundamental changes in C-band licensing and coordination policies.[15] The record shows that C-band FSS is and will remain an essential part of the nation's communications ecosystem and plays a role that cannot simply be replicated or replaced by other transmission methodologies.

Significantly, the communities that rely most heavily on C-band FSS are smaller cities and rural areas, and residents of these areas would be the hardest hit by any impairment of C-band FSS operations. Many households could lose access to the diverse range of programming and advanced video services they enjoy today, creating a new variation on the digital divide that already affects so many rural communities. For residents beyond the reach of terrestrial networks, losing C-band satellite connectivity could even be life-threatening, cutting them off completely from any means of summoning help in an emergency.

[14] NCTA Comments at 4.

[15] *See* Petition to Dismiss or Deny of the Satellite Industry Association, RM-11778, filed Jan. 9, 2017; Reply of the Satellite Industry Association, RM-11778, filed Jan. 24, 2017; Opposition of the Satellite Industry Association, RM-11791, filed Aug. 7, 2017; Reply of the Satellite Industry Association, RM-11791, filed Aug. 22, 2017.

Such outcomes clearly are not in the public interest. The Commission must ensure that C-band FSS services that are essential to millions of Americans are protected and allowed to continue to grow in response to customer demand.

I. THE RECORD CONFIRMS THAT C-BAND SATELLITE CAPACITY IS ROBUSTLY USED TO PROVIDE ESSENTIAL SERVICES

The comments in response to the NOI detail the myriad ways in which C-band satellite capacity is used to benefit U.S. consumers. The broad coverage areas and high reliability possible in C-band spectrum offer distinct advantages over other communications technologies and drive strong ongoing demand for C-band FSS. These factors have led to the deployment of a resilient, ubiquitous network, with space stations capable of serving every part of the country and a widely-dispersed array of thousands of receive earth stations able to make full and efficient use of the spectrum.

A. C-Band Satellite Networks Are Integral to the Nation's Infrastructure, Supporting Programming Distribution and Supplying a Range of Services Critical to Connectivity, Public Safety and National Security

The record is replete with examples of the vital, albeit behind-the-scenes, role played by C-band satellites. These spacecraft distribute video and audio signals on a 24/7 basis and are used for long-haul communications links, connectivity for remote areas, mobile backhaul, and safety of life services such as emergency alerts and weather and air traffic data.

Disney, CBS, Scripps, Time Warner, Fox, and Viacom explain that they rely on C-band FSS capacity to distribute content to more than 100 million U.S. television households:

> The C-band spectrum is used to deliver programming to each of the thousands of head-ends of multichannel video programming distributors ("MVPDs") and each of the well over 1,000 broadcast television stations affiliated with national television networks. It likewise is used to deliver content to over-the-top video distributors. Moreover, the on-site newsgathering and live event audio and video essential to producing breaking news, sports, and

> other programming also depends upon the C-band, using temporary fixed uplinks to transport video from the field back to studios and on to viewers.[16]

Similarly, the National Association of Broadcasters states that:

> Virtually every U.S. television and radio household relies on C-Band satellite operations for content distribution in some manner. Hundreds of broadcast television stations and thousands of radio stations in the U.S. rely on [FSS] earth stations to receive network and other syndicated programming that these television and radio stations then transmit to viewers and listeners.[17]

Religious broadcaster Eternal Word Television Network states that it relies on C-band satellites to distribute both television and radio programming that serves more than 91 million U.S. television households and millions more radio listeners.[18] Both NPR and iHeartMedia rely on C-band FSS to distribute radio programming to their affiliated radio stations.[19] Satellite Digital Audio Radio Service ("SDARS") provider Sirius XM receives third-party audio content from multiple sources via C-band satellites.[20] Significantly, this content includes not only sports and entertainment programming but also news and weather information that can be critical to public safety. For example, Sirius XM notes that during hurricanes Harvey and Irma, it made The Weather Channel – which it receives via a C-band satellite feed – available free-to-air to the more than 100 million SDARS receivers.[21]

[16] Content Company Comments at 2.

[17] NAB Comments at 2.

[18] Comments of Eternal Word Television Network, Inc., GN Docket No. 17-183, filed Oct. 2, 2017 ("EWTN Comments") at 4 & n.5.

[19] NPR Comments at 4; iHeartMedia Comments at 2.

[20] Sirius XM Comments at 5-6.

[21] *Id.* at 7.

AT&T emphasizes that it uses C-band FSS not just to support its DirecTV and U-Verse video services but also as part of its long-haul telecommunications plant.[22] AT&T has disaster response teams able to quickly deploy C-band antennas to restore service following natural disasters such as hurricanes[23] and just this week requested special temporary authority to operate a network of C-band temporary fixed earth stations to help restore communications in Puerto Rico.[24] In addition, AT&T operates C-band earth stations in five states that are used as part of its international telecommunications services.[25]

Both AT&T and GCI also rely on C-band satellites to serve communities in remote parts of Alaska that lack terrestrial alternatives. AT&T notes that the interconnectivity provided by the mix of 183 fixed and transportable earth stations deployed by AT&T Alascom "is essential for the safety and well-being of residents at these locations because it is often the only communications infrastructure available to the local communities."[26] For its part, GCI states that it "has over 130 C-Band sites in Alaska (many of which are equipped with multiple antennas), ranging from hub sites in large cities like Anchorage and Fairbanks to small, remote islands such as Atka and Nikolski."[27] GCI uses this network to serve customers in areas that "rely exclusively on satellite technology for the provision of basic telephone service, medical service,

[22] AT&T Comments at 5.

[23] *Id.* at 8.

[24] *See* AT&T Corp., File No. SES-STA-20171113-01244.

[25] AT&T Comments at 8.

[26] *Id.* at 9.

[27] GCI Comments at 5.

and distance-learning."[28] GCI also uses C-band FSS for "middle mile backhaul services as well as for traditional video content distribution."[29]

C-band FSS also plays a critical role in the Emergency Alert System ("EAS") administered by the Commission in conjunction with the Federal Emergency Management Agency ("FEMA"). iHeartMedia notes that it uses C-band satellites to transmit EAS alerts to more than 5,000 affiliates that are part of its Premiere Networks syndicated programming service.[30] NPR's C-band Public Radio Satellite System serves as a Primary Entry Point ("PEP") and can relay EAS messages to its 1,278 affiliated radio stations.[31] Sirius XM also acts as a PEP and has partnered with FEMA to provide a backup mechanism for distributing EAS alerts.[32]

Other civilian and military government agencies depend on C-band satellite connectivity as well. GCI has worked with the Federal Aviation Administration ("FAA") for over a decade on a program that supplies real-time weather camera information to pilots using the GCI satellite network.[33] FAA data show that the program has reduced weather-related aviation incidents in Alaska by 85 percent.[34] The FAA also uses C-band satellite capacity to link its primary air traffic control center in Alaska with other FAA facilities in that region.[35] Commercial C-band

[28] *Id.* at 2-3.

[29] *Id.* at 5 (footnote omitted).

[30] iHeartMedia Comments at 1-2.

[31] NPR Comments at 9-10.

[32] Sirius XM Comments at 8.

[33] GCI Comments at 11.

[34] *Id.*

[35] SIA Comments at 11-12 & n.21. *See also* ASRI Reply at 2 (C-band FSS is used for backhaul of air traffic management data, allowing "reliable remote links to aviation communications sites that are in (primarily) remote or underserved locations where existing wired infrastructure is not available or [is] unreliable").

capacity is also used for the distribution of National Weather Service reports and forecasts by the National Oceanic and Atmospheric Association's NOAAPORT network.[36]

Military uses of C-band satellite include a network that provides missile warning, space surveillance, space control, and satellite command and control.[37] C-band satellites support U.S. Army Intelligence and Security Command requirements as well as a U.S. Navy program that provides wideband satellite communications to naval vessels.[38]

Commercial ships such as ferries, cruise ships, and container ships traveling in U.S. territorial and international waters similarly utilize C-band FSS capacity pursuant to Commission-issued licenses for earth stations on vessels.[39] This connectivity allows crew and passenger voice services and internet connectivity as well as distribution of maps and other operational data.[40]

B. Demand for C-Band Satellite Services Is Strong

The ability of C-band satellites to blanket the country and supply near-perfect reliability creates a unique value proposition and supports strong ongoing demand for FSS in this spectrum. Parties that argue FSS use of C-band spectrum is declining[41] ignore the strong evidence to the contrary that shows continued dependence on C-band satellite operations.

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[36] SIA Comments at 11.

[37] *Id.* at 10.

[38] *Id.* at 11.

[39] *Id.* at 14.

[40] *Id.*

[41] *See, e.g.*, Comments of CTIA, GN Docket No. 17-183, filed Oct. 2, 2017 ("CTIA Comments") at 2; Comments of Nokia, GN Docket No. 17-183, filed Oct. 2, 2017 ("Nokia Comments") at 2; Comments of T-Mobile USA, Inc., GN Docket No. 17-183, filed Oct. 2, 2017 ("T-Mobile Comments") at 2.

In particular, the record demonstrates that investment in space segment remains robust, with dozens of in-orbit C-band satellites that are authorized to serve the U.S. and more being added. SIA member SES recently launched SES-11, which will provide follow-on C-band capacity at the nominal 105° W.L. orbital location, and plans to launch SES-14, which will replace C-band capacity at 47.5° W.L., early next year.[42] Intelsat has filed for authority to replace C-band capacity at the 125° W.L. and 133° W.L. orbital locations.[43] Each of these satellites represents an investment of hundreds of millions of dollars, indicating that satellite operators have projected that revenue from ongoing satellite use will justify these costs.

As discussed above, many of the misguided claims that C-band satellite usage is waning cite IBFS earth station data,[44] ignoring the fact that the number of sites registered in IBFS substantially underrepresents the deployed C-band FSS infrastructure. Google, for example, falsely states that "essentially all earth station sites that require protection are . . . registered in IBFS."[45] Verizon suggests that there is a "modest number of incumbent operations" in C-band spectrum, noting that a review of IBFS "reveals fewer than 1,500 unique FSS licensees."[46] As SIA and other satellite industry members have repeatedly emphasized, however, because there are thousands of C-band receive earth stations that are unregistered, IBFS data and trends do not

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[42] *See* https://www.ses.com/our-coverage/launches.

[43] SIA Comments at 17 & n.31.

[44] *See, e.g.*, Comments of the Computing Technology Industry Association, GN Docket No. 17-183, filed Oct. 2, 2017 ("CompTIA Comments") at 2; Nokia Comments at 6-8; T-Mobile Comments at 13; Comments of Verizon, GN Docket No. 17-183, filed Oct. 2, 2017 ("Verizon Comments") at 11-12.

[45] Comments of Google LLC and Alphabet Access, GN Docket No. 17-183, filed Oct. 2, 2017 ("Google Comments") at 4.

[46] Verizon Comments at 15. Any focus on the number of earth station licensees completely misses the point that there are thousands of earth stations in use and millions of Americans that indirectly rely on the services carried over those earth stations.

provide reliable information regarding C-band satellite service demand and equipment deployment.[47]

Claims of C-band FSS decline based on earth station renewal applications are even more misleading. CTIA refers to data submitted by the Broadband Access Coalition ("BAC") in support of its petition for rulemaking earlier this year noting that earth station registration renewals dropped to "0 for the last four years,"[48] and Verizon similarly points to decreasing numbers of C-band earth station renewal applications.[49] But as SIA explained in its opposition to the BAC Petition, the fact that no C-band renewal applications were filed in the past several years has "a simple and straightforward explanation."[50] Specifically, when a Commission decision extending earth station license periods from ten to fifteen years took effect in 2002, it "created a five-year period between 2012 and 2017 when no earth station renewal applications were due."[51] Thus, the lack of C-band renewal applications filed over this time period is evidence of nothing other than the fact that no C-band licenses or registrations expired during this five-year span.

A number of terrestrial parties also make wholly unsupported claims to provide an explanation for the purported shift away from C-band FSS. Nokia, for example, states that it "understands" that "the trend away from the 3.7 GHz band can be attributed in large part to migration to other spectrum bands as well as a trend away from wireless altogether onto

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[47] *See, e.g.*, SIA Comments at 18-19; NAB Comments at 3-4; SES Comments at 6.

[48] CTIA Comments at 8 & n.23, *citing* Broadband Access Coalition, Petition for Rulemaking, RM-11791, filed June 21, 2017 ("BAC Petition") at 15 & Ex. 3.

[49] Verizon Comments at 15 n.44.

[50] Opposition of the Satellite Industry Association, RM-11791, filed Aug. 7, 2017, at 5.

[51] *Id.*, at 5 & n.14, *citing Amendment of the Commission's Space Station Licensing Rules and Policies*, Notice of Proposed Rulemaking and First Report and Order, 17 FCC Rcd 3847, 3895 (2002).

increasingly ubiquitous fiber technologies."[52] Similarly, Federated Wireless claims that "video delivery has moved to alternate facilities, such as the Ku- and Ka-bands, as well as wireline and wireless networks."[53] Neither entity provides any evidence to support these assertions, which are contradicted by the ample data in the record showing that C-band FSS continues to be the gold standard for video delivery.[54]

More disturbingly, Federated Wireless appears to simply misrepresent the findings of a National Telecommunications and Information Administration ("NTIA") publication assessing government use of 3.7-4.2 GHz spectrum.[55] Specifically, Federated Wireless alleges that "federal C-band users have . . . been moving their operations to alternative facilities."[56] But the cited NTIA paper makes no such statement – to the contrary, the brief document observes that the predominant use of the 3.7-4.2 GHz band "by the Federal agencies is for receiving earth stations in the fixed-satellite service accessing commercial systems"[57] and concludes with the statement that "Federal use of this band is expected to increase."[58]

Ultimately, however, the Commission should simply disregard any assertions or predictions from the terrestrial wireless community about demand for C-band FSS and look

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[52] Nokia Comments at 7.

[53] Comments of Federated Wireless, Inc., GN Docket No. 17-183, filed Oct. 2, 2017 ("Federated Wireless Comments") at 10.

[54] *See, e.g.,* AT&T Comments at 7 ("C-Band is particularly prized for cable and IP video transmission, since signal quality and uptime are critical issues").

[55] Federated Wireless Comments at 10 & n.25, *citing* National Telecommunications and Information Administration, Federal Government Spectrum Compendium – 3700-4200 MHz, *available at* https://www.ntia.doc.gov/files/ntia/publications/compendium/3700.00-4200.00_01DEC15.pdf ("NTIA Compendium").

[56] Federated Wireless Comments at 10.

[57] NTIA Compendium at 3.

[58] *Id.* at 4.

instead to the submissions of parties qualified to make informed statements on these matters – entities that rely on C-band satellite services themselves. These commenters confirm that they expect usage of C-band FSS capacity to remain steady or grow.

AT&T, for example, observes that its use of C-band capacity in support of its DirecTV and U-Verse operations is "relatively static" but also "relatively inflexible."[59] AT&T goes on to explain that because "many content producers continue to utilize C-band FSS for distribution or redundancy," use of C-band satellites for "video content distribution does not appear to be decreasing."[60]

NCTA reports that it polled its membership to assess their use of C-band FSS:

> The results indicated that members continue to use thousands of C-band earth station antennas to transmit and receive programming. Even as cable system operators continue to expand their fiber networks, C-band earth stations remain a primary means of receiving content for distribution to customers. Several operator and programmer members indicated an intent to construct new earth station facilities in the next few years.[61]

NPR emphasizes that C-band satellite service remains essential to its mission. Specifically, NPR continues to rely on satellite technology because it is the most economical and reliable method for it to deliver programming to its widely-scattered network of public radio stations.[62]

Similarly, the ACA emphasizes that for many of its members, "the C-band is the only method by which they receive cable programming, as alternative conduits are unavailable, inadequate or inefficient and would have to be paid for by the cable operators themselves,

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[59] AT&T Comments at 7.

[60] *Id.*

[61] NCTA Comments at 3.

[62] NPR Comments at 6.

burdening further the finances of rural businesses counting every penny to make ends meet."[63] Moreover, the ACA expects demand for C-band satellite capacity to grow in the future in order to accommodate the trend toward ever-higher video quality, which requires more and more bandwidth. The ACA explains that "the inexorable progress towards 4K resolution" will drive an increase in the number of C-band transponders and channels needed for video distribution on a national level.[64]

In short, commenters in the best position to forecast C-band FSS demand unanimously indicate that the need for such capacity will continue to be robust.

C. Users Rely on Thousands of C-band Receive Earth Stations, Most of Which Are Not Listed in the Commission's Database

Evidence of this strong demand is provided by data regarding the significant numbers and ubiquitous deployment of C-band receive earth stations in use today. In particular, the record demonstrates that in addition to the licensed and registered earth stations listed in IBFS, there are thousands – or even tens of thousands – of unregistered receive-only earth stations communicating with C-band satellites today. As the ACA observes, the "vast majority of currently operational receive-only earth stations are not and never have been registered with the Commission, and thus are not included in the Commission's estimate of 4,700 earth stations using the downlink band."[65]

Simple arithmetic confirms that IBFS information significantly undercounts the actual number of operating receive earth stations. As the SIA Comments observe, cable headends alone account for roughly 4,800 receive antennas, exceeding the combined total for licensed and

[63] ACA Comments at 2.

[64] *Id.* at 15.

[65] ACA Comments at 4 n.6.

registered earth stations listed in IBFS,[66] and a single Intelsat customer has more than 3,700 unregistered receive-only antennas.[67] Adding in the hundreds of television broadcast affiliates and thousands of terrestrial radio stations that receive programming via C-band satellites pushes the total even higher. For example, NPR notes that public radio stations connected to its satellite network operate 475 receive-only earth stations,[68] and iHeartMedia indicates that it employs more than 260 receive-only earth stations and distributes syndicated programming to 5,000 Premiere Networks affiliates via their receive-only facilities.[69]

Indeed, the comments make clear that the vast majority of receive earth stations currently in operation are unregistered. Some parties explicitly acknowledge that none of their receive-only C-band ground stations is registered.[70] The ACA estimates that up to 90% of its members' roughly 3,000 current receive-only earth stations are unregistered.[71] NCTA does not provide a specific registration percentage but states that based on polling results, "members have not registered many of their earth station receive antennas."[72] NCTA goes on to observe that if its "members' practices reflect the registration practices of other C-band users, relying on data only for registered earth stations would significantly underrepresent how heavily the band is currently

[66] *See* SIA Comments at 7 & n.9, 18.

[67] *Id.* at 18 & n.35.

[68] NPR Comments at 4.

[69] iHeartMedia Comments at 2.

[70] *See, e.g.,* iHeartMedia Comments at 3 & n.2; Sirius XM Comments at 5.

[71] ACA Comments at 4 n.6.

[72] NCTA Comments at 3.

used by C-band satellite incumbents."[73] Similarly, NAB states that it "believes there are thousands of unregistered earth stations operating in the C-band."[74]

Given these facts, assertions by some commenters that IBFS overstates the number of C-band receive earth stations in use[75] must be rejected. SIA has acknowledged that an audit of the earth station database is appropriate to remove entries for which facilities were never built or were disassembled and to update entries that have inaccurate coordinates.[76] But the number of unregistered active receive-only earth stations clearly dwarfs any reasonable estimate of IBFS entries that are inaccurate. Google, for example, argues that 29% of the C-band earth station licenses and registrations in IBFS are flawed.[77] Accepting that estimate would suggest that 1363 entries should be culled from the database, leaving 3,337 licensed or registered C-band receive earth stations. As discussed above, however, counting only the receive earth stations reported by commenters in the record here produces a total several times that number.

Indeed, if the ACA's estimate that only one in ten of its members' earth stations are registered is representative of other C-band users, then the total number of active receive-only facilities is in the tens of thousands. Specifically, if a corrected IBFS database number is 3,337 earth stations, that suggests that more than 30,000 earth stations are unregistered, leading to a total of over 33,000 C-band receive earth stations nationwide.

[73] *Id.* at 18 & n.35.

[74] NAB Comments at 3.

[75] *See, e.g.*, Nokia Comments at 7-8; Comments of Dynamic Spectrum Alliance, GN Docket No. 17-183, filed Oct. 2, 2017 ("DSA Comments") at 5.

[76] SIA Opposition to BAC Petition at 8-9.

[77] *See* Google Comments at 4-5.

D. FSS Flexibility to Operate Full-Band and Full-Arc Serves the Public Interest

The comments make clear that many of these users require access to a wide range of C-band frequencies and a significant portion of the orbital arc. NAB, for example, explains that "[b]roadcast stations routinely need to access programming from different network feeds or other sources, which may be on almost any transponder or satellite."[78] GCI notes that it "uses the entire 500 MHz C-Band receive spectrum allocation on many of its sites and currently operates on three full time satellites, with its stations configured to restore services across two additional satellites at different orbital locations than their primary service locations."[79] Sirius XM similarly observes that its "ability to receive C-band downlink signals must be protected across the full frequency range and for a broad segment of the orbital arc," as it has "no control over which satellites and transponder assignments are used to deliver the content channels carried over its SDARS system."[80]

The North American Broadcasters Association emphasizes that:

> There is an operational need to reconfigure an earth station so that it can be pointed toward different satellites and tuned to different frequencies to receive signals from different transponders. One example of this operational need is a switch from a failed transponder to a backup either on the same satellite or on a different one. Another example is the need to switch satellite entirely if there is an in-orbit failure or "Sun Outage." Or, as another example, sometimes programming from a special event is distributed on a different channel through a transponder on an alternate satellite due to scheduling conflicts or other needs.[81]

[78] NPR Comments at 4.

[79] GCI Comments at 5.

[80] Sirius XM Comments at 10.

[81] Comments of the North American Broadcasters Association, GN Docket No. 17-183, filed Sept. 29, 2017 ("NABA Comments") at 5.

In short, claims that a "typical earth station is only using 23-36 megahertz"[82] are contradicted by the evidence that many earth station operators routinely receive signals over a variety of C-band spectrum segments and frequently must reorient their antennas towards different satellites.

The flexibility to switch among satellites and frequency segments also is essential to enable restoration in the event of an outage. NPR emphasizes that "[t]o operate effectively, earth stations must have the ability to reorient to different frequencies or different satellites in case of a disruptive event."[83] NPR goes on to explain that the failure of Galaxy IV in 1998 led to serious disruption of its programming distribution, but absent full-band, full-arc licensing authority for its primary uplink earth station, the delays and expenses associated with restoring full service would have been much greater.[84] SES recounts a more recent example related to a customer whose video distribution network was affected when the AMC-9 satellite failed.[85] SES notes that without full-band, full-arc earth station licensing, "reestablishing service to that customer on a timely basis would have been impossible."[86]

The Commission's full-band, full-arc licensing policy also has an important pro-competitive effect by allowing space segment buyers to switch satellites in order to get a better deal. The ACA explains that eliminating the policy would lock such customers into their existing arrangements, removing an important downward pressure on costs.[87]

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[82] Comments of the Broadband Access Coalition, GN Docket No. 17-183, filed Oct. 2, 2017 ("BAC Comments") at 6.

[83] NPR Comments at 11.

[84] *Id.* at 12.

[85] SES Comments at 4.

[86] *Id.*

[87] *See* ACA Comments at 18-19.

Thus, full-band, full-arc licensing promotes important Commission objectives, enabling delivery of a broad range of programming to broadcasters and MVPDs, speeding the restoration of service to customers affected by a satellite outage, and advancing competition for the benefit of users.

II. SUGGESTED APPROACHES TO REPLACE OR REDUCE DEMAND FOR C-BAND FSS ARE INFEASIBLE, COSTLY, AND WASTEFUL

Assertions that C-band satellite services can be switched to other satellite spectrum or entirely to fiber, or that reliance on C-band FSS can be reduced through advanced compression methodologies, are groundless. Customers choose C-band FSS over alternatives for a reason. As NPR explains, it "continues to use satellite technology as its primary delivery platform because satellite continues to be the most cost-effective and reliable means of delivering high-quality audio programming to a national network of public radio stations serving hard to reach and geographically diverse communities."[88] The proposed alternatives to C-band satellite service – individually or in combination – cannot provide the high reliability of C-band FSS networks. Moreover, attempting to replace the C-band satellite communications backbone would be extremely costly and would strand billions of dollars in space and ground station infrastructure.

A. Ku- and Ka-band Satellites Cannot Take the Place of C-band FSS

A number of terrestrial industry commenters propose shifting C-band operations to Ku- or Ka-band satellites,[89] but contrary to the apparent belief of these parties, satellite spectrum and satellite networks are not interchangeable. Different frequency bands have different propagation

[88] NPR Comments at 6.

[89] *See, e.g.,* CTIA Comments at 10-11; Ericsson Comments at 7; Verizon Comments at 17-18.

characteristics and are best suited for different types of customer bases. Attempting to force C-band users to switch to Ku- or Ka-band satellites is the equivalent of trying to put a square peg in a round hole.

A threshold problem is the lack of available round holes. Both Ku- and Ka-band satellites are in active use and have very little idle capacity.[90] Certainly, any usable unoccupied bandwidth is nowhere near enough to replace the hundreds of transponders on dozens of satellites that are used today for C-band content delivery alone.[91]

Moreover, C-band FSS is resistant to atmospheric attenuation, allowing near-100% reliability levels, a critical factor for content providers. Higher frequencies are more susceptible to rain fade effects that can disrupt signal reception. As AT&T explains:

> Among available satellite bands, C-Band is particularly prized for cable and IP video transmission, since signal quality and uptime are critical issues. Weather impacts, such as fog, particles and rain, cause signal fade in the Ku-Band, and make the C-Band a better choice for these types of applications.[92]

Given the paramount importance of signal quality and continuity for video delivery, the high reliability of C-band overrides any potential benefits of using higher frequency bands.

Suggested measures to ameliorate rain fade are wholly incompatible with the demands of high quality, real-time video distribution. For example, CTIA posits that adaptive coding and modulation ("ACM") can enable a shift from C-band to higher frequency satellite systems, citing

[90] *See* ACA Comments at 16 n.30 ("ACA understands that all Ku-band transponders are full, with demand exceeding supply").

[91] *See id.* at 2 ("video programming carried by C-band satellites comprises an astonishing number of channels – almost 2,000 – and takes 308 transponders on 24 satellites").

[92] AT&T Comments at 7.

a study commissioned by terrestrial service interests in Europe.[93] ACM involves adjusting the modulation and forward error correction of a signal to overcome path loss, and can be useful for services such as two-way data carriage over very small aperture terminal ("VSAT") networks. Indeed, only VSAT networks are mentioned in the UMTS Forum Study in its discussion of ACM permitting migration of services from the C-band to higher frequencies.[94] VSAT networks, though, are not major users of C-band satellite capacity in the U.S.

For the one-way video delivery services that use the vast bulk of U.S. C-band FSS capacity, ACM is not a workable approach. As a threshold matter, ACM requires the presence of a return channel mechanism to inform the uplink of a rain fade effect that requires lowering the bit rate. The receive-only earth stations used for programming delivery, of course, have no such transmit capability. In any event, because ACM involves lowering the bit rate, the received quality of the signal is decreased. A content provider sending out live, high definition coverage of the Super Bowl, or any linear television programming, expects a real-time HD signal to be delivered, whether it is raining or not, and that is possible only if the satellite signal uses C-band spectrum.

CTIA also suggests that the use of multiple spot beams in some Ku- and Ka-band satellites would be advantageous to current C-band FSS users,[95] but the opposite is true. Small spot beam architecture does not economically or operationally lend itself to the distribution of video and audio content nationwide because the process of transmitting each video or audio

[93] CTIA Comments at 11, *citing* UMTS FORUM, STUDY ON SPECTRUM USES, TRENDS AND DEMANDS IN THE RANGE 3400-4200 MHZ (C-BAND) 2 (Apr. 22, 2014), https://cept.org/Documents/ecc-pt1/17536/ecc-pt1-14-050_study-on-spectrum-uses-trends-and-demands-in-the-range-3400-4200-mhz-c-band (the "UMTS Forum Study").

[94] *See* UMTS Forum Study at 2.

[95] CTIA Comments at 10-11.

channel would have to be duplicated for each spot beam, multiplying operational complexity and cost. Ka-band high-throughput satellites typically have over one hundred spot beams, which makes them well-suited for delivering high data rates within each individual spot beam footprint. To achieve nationwide coverage, though, the same programming signal would have to be replicated in each of the hundred-plus spot beams, eliminating any frequency reuse gains from the spot beam architecture.

Thus, Ku- and Ka-band satellites are not substantially equivalent alternatives to the existing C-band FSS infrastructure. Even if there were usable idle capacity in other bands, the deployed network of ground infrastructure would have to be replaced at tremendous cost to earth station operators. To shift to Ku- or Ka-band satellite delivery, earth station operators would have to buy new equipment, abandoning the facilities they have already purchased at significant expense. These costs would place an especially weighty burden on cable systems and broadcasters serving smaller communities.

Moreover, a mandated shift from C-band to other satellite frequencies would strand billions of dollars' worth of existing, fully capable C-band space assets. These assets include brand-new satellites, such as SES-11, with expected lifetimes in excess of fifteen years. Regulatory sterilization of such valuable facilities would be irrational and irresponsible.

Contrary to the suggestion by Verizon, neither the "bent pipe" design of some in-orbit satellites nor the fact that many C-band payloads are carried on hybrid satellites that also operate in the Ku-band has any relevance to "whether the Ku-band could accommodate C-band traffic with minimal equipment modifications."[96] Verizon does not adequately explain why it believes these two factors might "reduce the cost and complication of transitioning satellite systems to

[96] Verizon Comments at 17.

new bands."[97] If Verizon is implying that the existence of hybrid C/Ku-band bent pipe satellites would allow traffic to be uplinked in C-band and downlinked in Ku-band, that is simply not the case. As Verizon states, a satellite with a bent pipe design does shift the signal from the uplink frequency channel to the downlink frequency channel,[98] but that occurs within the C-band or within the Ku-band. The vast majority of C/Ku-band hybrid satellites operating today were not designed to permit cross-strapping from an uplink channel in one band to a downlink channel in another and cannot be so modified in orbit. On the ground segment side, as discussed above, a shift in frequencies would require wholesale equipment replacement. Thus, the fact that a C-band earth station may be receiving a signal from a satellite that also has a Ku-band payload would have no effect on the costs of shifting to use of the higher frequency band.

B. Fiber Cannot Replicate the Nationwide Coverage of C-band FSS

Suggestions that fiber can substitute for the ubiquitously-deployed C-band satellite network[99] are similarly without merit. The limited fiber facilities available simply cannot match the blanket 50-state coverage of C-band satellites, and extending fiber to additional locations is extremely expensive. As a result, U.S. consumers in smaller communities beyond the reach of the fiber network would lose access to the diverse, technically advanced video programming options they receive today.

The record makes clear that fiber access is available only in more densely populated areas. T-Mobile cites to an estimate that fiber is available in 283 cities as evidence that the long-

[97] *Id*. at 18.

[98] *Id*. at 17 n.50.

[99] *See, e.g.,* CTIA Comments at 11-12; Ericsson Comments at 7; T-Mobile Comments at 14; Verizon Comments at 18.

haul fiber infrastructure in the U.S. is "robust."[100] In contrast, the C-band FSS infrastructure extends to *every* city in the U.S., not to mention rural areas and even Alaskan bush villages. National content providers cannot meet their service commitments by distributing programming to just 283 cities. The modest geographic scope of existing fiber deployments thus disqualifies fiber from consideration as a complete stand-in for C-band FSS.

Furthermore, commenters demonstrate that extending fiber networks to more rural locations would be prohibitively expensive for most satellite customers. The ACA submits a detailed accounting of the costs associated with bringing fiber access to cable headends that lack such access today – noting that typically, the gap that must be bridged is 10-15 miles long.[101] The ACA concludes that the "cost of deploying fiber to a headend from the nearest transit provider could easily run to millions of dollars for cable operators without such access today, depending on the distance and the terrain that the fiber would have to traverse."[102] The ACA makes clear that the "costs associated with fiber deployment and leasing would be prohibitive for most of ACA's smallest operators, and would require others to pass along significant cost increases to their customers."[103]

Thus, relying on fiber as a substitute for C-band satellite service would leave cable systems and broadcasters outside of urban areas with no affordable means to access the video content available to city dwellers. Viewers served by these systems, many of whom are victims of the existing "digital divide" in broadband access, are unlikely to be able to rely on alternative means of video delivery, such as over-the-top transmission. In short, a mandated shift to fiber

[100] T-Mobile Comments at 14.

[101] ACA Comments at 16-17.

[102] *Id.* at 16.

[103] *Id.* at 17-18.

would create a new divide between residents of metropolitan areas, who would continue to be able to enjoy a full array of the most advanced video services, and their counterparts in more rural areas, who would see their viewing choices dwindle dramatically. Such an outcome would be contrary to the Commission's core statutory objective of making communications services available "to all the people of the United States."[104]

Even in the areas where fiber is available, moreover, redundant paths may be required. AT&T notes that because fiber systems can be subject to cable cuts, which it refers to as "backhoe fade," AT&T "has found that C-Band availability . . . often exceeds that of fiber."[105] Such damage to the fiber network is particularly likely following a natural disaster, when residents of the area are most in need of reliable access to news and weather information. For example, cuts to the underground fiber system in the U.S. Virgin Islands increased in the weeks after the recent hurricanes, as residents trying to hack their way out of their homes severed fiber lines.[106] The only way to mitigate the risk of cable cuts is to deploy redundant fiber capacity, multiplying the cost that would have to be borne by users.[107]

Finally, a mandated switch to fiber – even if it were a viable substitute for satellite capacity – would strand billions of dollars that have been invested in C-band space and ground

[104] 47 U.S.C. § 151.

[105] AT&T Comments at 7.

[106] *See* "Strong Local Regulatory Key to Virgin Islands Hurricane Response, NARUC Told," Communications Daily, Nov. 15, 2017 at 14 ("Buried fiber survived the storm, but three days later there were four cuts, a week later 17 and now 48.").

[107] *See* ACA Comments at 17 n.34 (observing that its estimated costs for extending fiber networks do not include installing back-up fiber – an additional fiber line that takes a different route to the node – which it understands is "standard practice" to provide redundancy in the event the primary line is damaged).

segment facilities. As discussed above, there is no possible public interest justification for abandoning this vital component of the existing telecommunications infrastructure.

C. Compression Gains Have Been Offset by Increased Bandwidth Demand

CTIA's suggestion that compression technologies "could allow [C-band] satellite traffic to be combined into a smaller number of transponders"[108] ignores the demands of high-quality video delivery services, the predominant use of C-band FSS. In particular, while compression technology has been used to increase the number of channels that can be carried per transponder, meeting customer demand for more channels and higher-quality video necessarily requires more capacity.

As the ACA explains:

> The C-band is most heavily used for backhauling video content. Video is the most bandwidth-intensive traffic to begin with, and live video even more so. The bandwidth demands it poses on any backhaul technology have been steadily increasing owing to the increase in the number of video channels over the last couple of decades, and, even more important, the increasing quality of the resolution that consumers demand. The countervailing technological improvements in compression and modulation have been unable to catch up.[109]

The ACA outlines in detail the progression of compression and modulation approaches designed to increase the number of video channels that can be carried on a single transponder.[110] But even as these technologies have evolved, they have not reduced the overall demand for C-band FSS capacity. Efficiencies achieved by decreasing the transponder space needed for each programming channel were used to make a larger, more diverse selection of channels available.

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[108] CTIA Comments at 12.

[109] ACA Comments at 5-6.

[110] *Id.* at 8-11.

Moreover, advances in video quality have created ever greater strains on available capacity. The transitions from standard definition to high definition to ultra high definition 4K each increased the capacity required and therefore decreased the number of channels that a single transponder can carry: while up to twenty standard definition channels can be carried on a single transponder, the per-transponder maximum for 4K channels is four, even with the most advanced compression techniques available.[111]

In short, the significant advancements that have been made in compression technology for video channels have been more than offset by the increased capacity needed to offer more channels and higher-quality video in response to customer demand.

III. SHARING C-BAND DOWNLINK SPECTRUM ON A CO-FREQUENCY, CO-COVERAGE BASIS IS NOT FEASIBLE

The idea that critical C-band FSS services can co-exist in the 3.7-4.2 GHz band with new terrestrial operations is just as unrealistic as the assumption that such services can readily be replaced. In particular, no party disputes the fact that required separation distances to protect receive earth stations will be significant – the lowest estimate in the record is 30 kilometers under a best-case scenario. A threshold problem with implementing these distances is that any efforts to protect receive earth stations require a detailed understanding of where each earth station is, and the Commission simply does not have that information. Moreover, given the public interest benefits of full-band, full-arc licensing, any protection scheme must assume that receive earth stations will continue to require the flexibility to switch channels and orientation. Under these circumstances, suggestions by some commenters that a database approach could be relied on to enable terrestrial use of the 3.7-4.2 GHz band are groundless.

[111] *Id.* at 9-10.

A. The Record Confirms that Significant Separation Distances Are Required to Protect Receive Earth Stations

As SIA and several other commenters observe, both theoretical analyses and empirical evidence confirm that co-frequency, co-coverage sharing between ubiquitously-deployed C-band receive earth stations and terrestrial mobile services is infeasible.[112] The findings on this subject are set forth in Report ITU-R S.2368, which was the product of analyses in which both FSS and terrestrial mobile interests from the U.S. and around the world participated. The report determined that:

> When FSS earth stations are deployed in a typical ubiquitous manner or with no individual licensing, sharing between [advanced terrestrial mobile service] and FSS is not feasible in the same geographical area since no minimum separation distance can be guaranteed.[113]

The report concluded that required separation distances between new terrestrial mobile facilities and receive earth stations would be in the tens of kilometers to 100 kilometers or more.[114] This range is consistent with the Commission's decision to use a coordination distance of 150 kilometers when it decided to permit new terrestrial operations in the 3.65-3.7 GHz band.[115]

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[112] *See* SIA Comments at 38-39; Content Company Comments at 8-9 & n.17; NAB Comments at 6-7 & n.6; NABA Comments at 4 & n.9.

[113] Sharing studies between International Mobile Telecommunication-Advanced systems and geostationary satellite networks in the fixed-satellite service in the 3 400-4 200 MHz and 4 500-4 800 MHz frequency bands in the WRC study cycle leading to WRC-15, Report ITU-R S.2368-0 (06/2015), available at: https://www.itu.int/dms_pub/itu-r/opb/rep/R-REP-S.2368-2015-PDF-E.pdf at 32.

[114] *Id.* at 31.

[115] *See* SIA Comments at 37-38 and n.73, *citing Wireless Operations in the 3650-3700 MHz Band,* Report and Order and Memorandum Opinion and Order, 20 FCC Rcd 6502, 6524-27 (2005); *see also* Comsearch Comments at 3 (observing that previous studies and shown that "the required stand-off distance to protect a co-frequency C-band earth station from interference can be

The results of an analysis performed by Ericsson are also generally consistent with the international studies. Specifically, Ericsson notes that its findings "indicate the need for at least 30 kilometers, under favorable conditions, of separation between a terrestrial wireless base station and a C-band earth station in order for the two services to co-exist on the same spectrum."[116] These "favorable conditions" include an assumption of very high elevation angles, which will not be achievable for many earth stations, and a protection criteria that is inadequate to ensure the high availability that video services require.[117] Ericsson's calculations reflecting a more feasible elevation angle and a greater level of protection resulted in required separation distances of 50-70 kilometers.[118]

As the Content Companies explain, the fundamental factor driving these large separation distances is "a simple matter of physics:"

> By design, receiving earth stations are extremely sensitive—a necessity in order to receive a low-power signal from a satellite transmitter orbiting the Earth some 22,236 miles above the surface of the equator. Signals from new fixed or mobile services—even if operating at what otherwise might be considered "low" power—thus have significant potential to interfere with the reception of satellite signals by earth stations operated by MVPDs, broadcast television stations, and others.[119]

Thus, there is a broad recognition, including on the part of terrestrial interests, that co-frequency, co-coverage spectrum sharing between terrestrial systems and large numbers of C-

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significant" and noting the adoption of the 150-kilometer coordination zones for the 3.65 GHz frequencies).

[116] Ericsson Comments at 8.

[117] *See id.,* Attachment A at 1 (30 kilometer estimate is based on a 40 degree elevation angle and an interference threshold of I/N=-3 dB).

[118] *Id.,* Attachment A at 3 (using an earth station elevation angle of 5 degrees and I/N values below -6 dB "leads to separation distances as high as 50-70 km").

[119] Content Company Comments at 6.

band receive earth stations is unworkable.[120] Instead, in order to prevent interference to sensitive C-band receive earth stations, "the Commission would need to establish large exclusion zones that would significantly impair the value of the spectrum for new users."[121]

B. All C-Band Satellite Services Must Be Protected

As discussed above, the evidence presented in this proceeding clearly shows that IBFS includes only a small fraction – perhaps as low as one-tenth – of the C-band receive earth stations that are deployed and operating.

This low registration rate is not surprising because registering C-band receive-only earth stations is simply not required. Furthermore, and as the SIA Comments note, the costs of registering a receive-only earth station clearly outweigh the benefits today.[122] Registration requires incurring the costs of preparing an IBFS application, including procuring a coordination report, which costs around $700, and paying the $435 per station application fee. In exchange, registration confers interference protection from any subsequently established terrestrial fixed service ("FS") point-to-point link. But as the NOI acknowledges, FS use of the 3.7-4.2 GHz band is low and dwindling further.[123] In these circumstances, registration imposes significant costs and provides protection only from a theoretical future FS link that is highly unlikely ever to be established. This calculus tips the balance strongly against registration.

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[120] *See, e.g.*, Nokia Comments at 11 ("preliminary study shows that the required exclusion zones around [fixed earth stations] could be a limiting factor for 5G deployments when the 5G and FSS systems are deployed co-channel," especially in dense urban areas); T-Mobile Comments at 14 ("It is not practical for mobile operators to coexist with large numbers of satellite receivers in . . . urban areas").

[121] NAB Comments at 6.

[122] SIA Comments at 19.

[123] NOI at ¶ 15.

The lack of complete and accurate information about C-band receive earth station deployment must be addressed in the near term. The Commission cannot weigh the policy implications of any proposal for new terrestrial usage of C-band spectrum without an adequate understanding of the extent of C-band FSS operations that might be harmed. Nor can the Commission implement needed protections for existing C-band earth stations if it lacks information regarding how many there are and where they are located.

As iHeartMedia emphasizes:

> Without a current, accurate assessment of the widespread, but unregistered, use of the 3.7-4.2 GHz band, any decisions by the Commission as to the feasibility of additional uses of this spectrum will risk serious disruption to the country's communications infrastructure, and the information, entertainment and sports programming relied upon by the public. Consequently, the Commission must undertake a more current, and more accurate, assessment of incumbent usage of the 3.7-4.2 GHz band prior to the consideration of this spectrum for wireless broadband or other additional services.[124]

The SIA Comments propose a number of actions to encourage earth station operators to register their earth stations.[125] In particular, the Commission should reduce or waive applicable fees. In addition, the Commission may want to dispense with the requirement to obtain and file a coordination report, as mandating that an earth station operator coordinate with already operating FS licensees that are not required to provide any protection to the earth station does not appear to serve any purpose.

Moreover, the Commission should provide adequate time to complete the registration process.[126] In particular, for operators of large networks of receive only earth stations,

[124] iHeartMedia Comments at 23-24.

[125] SIA Comments at 4.

[126] *Id.* at 24.

assembling the necessary data to complete even a streamlined registration process could take many months.

C. Retaining Full-Band, Full-Arc Earth Station Licensing Is Critical

As discussed above, full-band, full-arc earth station licensing remains essential to the robust and efficient use of satellite networks and must be preserved. Many earth station operators routinely access multiple satellites and frequency segments to receive a range of programming. Others might primarily rely on a single satellite but require the flexibility to implement changes in order to restore service in the event of an outage, shift traffic when a satellite is nearing its end of life, respond to changing demand, resolve interference issues, and take advantage of competition.

Arguments suggesting that the policy is unnecessary reveal a misunderstanding of space and earth station operations. For example, CTIA suggests that the Commission could modify the full-arc policy by "repacking specific satellite traffic."[127] CTIA's theory is that:

> By moving remaining satellite traffic to satellites in orbital slots that are higher in the geostationary arc from the viewpoint of the FSS earth-station, the receive antennas will be pointed higher into the sky. As a result, the arc to be protected would be narrowed as earth station receive antennas would be pointed upward and not towards the horizon.[128]

Ironically, CTIA is proposing a modification of the full-band, full-arc licensing policy that would not be possible without the flexibility provided by full-band, full-arc licensing, as CTIA contemplates repointing of thousands of antennas. But CTIA also ignores both the requirements of satisfying demand for 50-state coverage and the basic geometry of earth station operations. A primary advantage of the propagation characteristics of C-band FSS is that a

[127] CTIA Comments at 14.

[128] *Id.*

single satellite can enable coverage nationwide – content can be uplinked from an origination site anywhere within the satellite's beam, and receive earth stations throughout the country will be able to receive the signal. But because the elevation angle of an earth station antenna is a function of multiple factors – the latitude and longitude of the earth station as well as the position of the satellite – elevation angles for antennas looking at that single satellite will vary widely from coast to coast and from south to north. A satellite in the western arc will permit higher elevation angles for earth stations in Alaska, but will have much lower elevation angles with respect to an earth station in Maine, and the opposite will be true for eastern arc satellites. The only way to optimize elevation angles in both Alaska and Maine is to use different satellites to serve them, an approach that would require content to be transmitted to multiple satellites to achieve 50-state coverage. Obviously, such a result would be spectrally inefficient and more costly to FSS customers.

Nokia also appears to misunderstand the mechanics of earth station operations with respect to full-band, full-arc licensing. Specifically, Nokia asserts that contrary to FSS statements regarding the need to orient antennas toward various points in the geostationary arc, many antennas are "bolted in place and cannot be easily repointed."[129] As SIA has indicated above, it is certainly true that not all earth stations are regularly reoriented towards different satellites – some instead remain pointed towards an individual spacecraft for a long period of time. Consistent with these varying use cases, some antennas are equipped with a system that allows repointing through an automated process, while others must be pointed and repointed manually. Under any circumstances, the antenna operator would take steps to make sure that both the antenna's supporting structure and the antenna itself are securely fastened in place to

[129] Nokia Comments at 9.

prevent the antenna's orientation from being altered by wind or other effects. But SIA is not aware of any situation in which an antenna operator would permanently fix an antenna in a given orientation such that repointing was not possible. Since no earth station operator can be sure that it will never need to perform a repointing, taking such an action would undermine the value of the operator's investment in its receive antenna equipment.

Ultimately, full-band, full-arc licensing continues to play the same critical role it always has in facilitating efficient satellite network operations:

> Our full-band licensing policy promotes important operational objectives in the FSS, in particular by providing earth station licensees the needed flexibility to change transponders or satellites on short notice, and without having to be re-licensed by the Commission, to meet changing operational requirements.[130]

The flexibility conferred by this long-standing licensing principle remains just as "necessary" today as it was two decades ago. Parties urging elimination of full-band, full-arc licensing[131] ignore the need to accommodate the unique operational requirements of satellite networks. No party has proposed an alternative to this policy that would accommodate the legitimate requirements of satellite service users. Accordingly, for the reasons expressed in detail in SIA's prior pleadings,[132] the Commission should continue to permit earth stations to modify their spectrum use and pointing as needed.

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[130] *FWCC Request for Declaratory Ruling on Partial-Band Licensing of Earth Stations in the Fixed-Satellite Service That Share Terrestrial Spectrum*, Notice of Proposed Rulemaking, 15 FCC Rcd 23127, 23146 ¶ 40 (2000).

[131] *See, e.g.*, Verizon Comments at 12-13; Comments of Microsoft Corporation, GN Docket No. 17-183, filed Oct. 2, 2017, at 3.

[132] *See* SIA Comments at 25-34; Petition to Dismiss or Deny of the Satellite Industry Association, RM-11778, filed Jan. 9, 2017; Reply of the Satellite Industry Association, RM-11778, filed Jan. 24, 2017; Opposition of the Satellite Industry Association, RM-11791, filed Aug. 7, 2017; Reply of the Satellite Industry Association, RM-11791, filed Aug. 22, 2017.

D. A Database Approach Is Impractical

Suggestions that the Commission should extend the database framework adopted for the Citizens Broadband Radio Service ("CBRS") in the 3.6 GHz band to the adjacent 3.7-4.2 GHz frequencies[133] must be rejected. As SIA and other parties explain, the CBRS approach has not yet been tested,[134] and its efficacy in protecting deployed earth stations in the 3.6-3.7 GHz band is therefore unknown. As a result, it is clearly premature to assume that a database management system could effectively be imported into the conventional C-band.

Multiple factors magnify the difficulty of applying a database approach in the 3.7-4.2 GHz frequencies. Importantly, this band is used by exponentially more FSS earth station antennas that would need interference protection than are present in the adjacent 3.6 GHz spectrum, and the vast majority of earth stations operating in the 3.7-4.2 GHz band are currently unregistered. Furthermore, the conventional C-band customer base provides essential video distribution services that could not tolerate signal degradation as a result of nearby terrestrial operations.[135] In the non-linear world of data communications, a caching delay while watching a YouTube video or an intermittent slow-down of a file download is considered completely

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[133] *See, e.g.,* Comsearch Comments at 3; DSA Comments at 10; Federated Wireless Comments at 4; Comments of Motorola Solutions, GN Docket No. 17-183, filed Oct. 2, 2017, at 1; Comments of Sony Electronics Inc., GN Docket No. 17-183, filed Oct. 2, 2017, at 1; Comments of Vivint Wireless, Inc., GN Docket No. 17-183, filed Oct. 2, 2017 ("Vivint Comments") at 3; Comments of the Wireless Innovation Forum, GN Docket No. 17-183, filed Oct. 2, 2017 ("WinnForum Comments") at 3.

[134] *See* SIA Comments at 39-41; Ericsson Comments at 6-7 (database approaches are still in development and have not yet been widely deployed); GCI Comments at 16 (the CBRS database approach "is still being developed and finalized, and neither the Commission nor industry participants know how or whether [it] will work").

[135] Vivint inexplicably asserts that FSS incumbents in the 3.7-4.2 GHz band have "generous link margin[s]." Vivint Comments at 3-4. As multiple commenters explain, however, received satellite signals are quite weak and highly susceptible to harmful interference. *See, e.g.,* Content Company Comments at 6.

acceptable. In contrast, near-100% reliability is required in the linear world of television distribution, and any signal degradation, no matter how brief or sporadic, is simply intolerable.

In this respect, the DSA's assertion that "sharing in [the 3.7-4.2 GHz] band with fixed incumbents would be far less complex and fully protect them with a much simpler database mechanism than in the 3.55-3.7 GHz band"[136] ignores the intricacies of managing interference to satellite services in the 3.7-4.2 GHz frequencies. SIA's Comments explain that implementing a database approach would be infinitely more complex in the conventional C-band:

> Given the required separation distances discussed above, a database attempting to determine whether to authorize a terrestrial wireless transmission in the 3.7-4.2 GHz band would need to consider the impact on hundreds or even thousands of C-band receive earth station antennas in the surrounding area. The sheer computing power needed to make each individual go or no-go determination for a terrestrial transmission request – taking into account the full set of relevant technical criteria for each earth station within a radius of tens or hundreds of kilometers in addition to the details regarding any other terrestrial operations in the vicinity – would be staggering. Attempting to make such decisions quickly, in communication with multiple database administrators, would be more challenging still.[137]

Enforcing a database's determinations regarding required separation distances would add a further level of complication. As NAB points out:

> Mobile operations . . . cannot be effectively prevented from operating in an exclusion zones. Any user with a mobile device operating on C-band frequencies could easily travel near an earth station. Even though base stations could be excluded from operations in the area, the user's mobile device would continue to attempt to make contact with a base station – and those attempted . . . transmissions could cause harmful interference to nearby earth stations. NAB is aware of no effective means of

[136] DSA Comments at 10.

[137] SIA Comments at 41.

> geofencing mobile users or mobile handsets from operation in exclusion zones.[138]

Similarly, none of the proponents of a database approach explains how a database would ensure adequate separation distances are maintained in order to protect mobile C-band satellite terminals, such as earth stations on vessels operating near shore, from unacceptable interference due to terrestrial operations.

The claim by WinnForum that spectrum sensing can play a role in facilitating opportunistic access the 3.7-4.2 GHz frequencies[139] is also unfounded and reflects a complete lack of understanding of satellite operations. As SIA has explained in other proceedings, because receive-only earth stations do not transmit at all, *there is no signal from such earth stations that can be "sensed."*[140] As a result, monitoring the satellite receive band will not help a terrestrial device or database determine whether there is an active receive earth station nearby whose operations might be disrupted by a terrestrial transmission.

Thus, forced introduction of new terrestrial operations on a co-frequency, co-coverage basis with vital satellite networks in the 3.7-4.2 GHz band is not workable. Separation distances required to protect tens of thousands of earth stations would be substantial, leaving little or no opportunity for terrestrial operations over vast portions of the country. And no proven database technology exists that would allow terrestrial operations in closer vicinity to receive earth stations based on a more specific propagation analysis. Under these circumstances, a forced

[138] NAB Comments at 7.

[139] WinnForum Comments at 5.

[140] *See, e.g.,* Reply Comments of the Satellite Industry Association, GN Docket No. 12-354, filed Apr. 5, 2013, at 16.

sharing solution would threaten vital earth station operations without providing material prospects for new terrestrial uses.

IV. GLOBAL INTEREST IN THE 3.7-4.2 GHz BAND IS LIMITED

Claims by some terrestrial parties that a Commission move to allow terrestrial mobile operations in the 3.7-4.2 GHz band would align with global trends and promote spectrum harmonization[141] are also overstated. Most administrations around the world are following the outcome of WRC-15, in which the 3.4-3.6 GHz band was globally identified for terrestrial mobile services (with very few exceptions), and a handful of countries have extended this range to 3.8 GHz, particularly in Europe. So while it is true that there is interest in mid-band spectrum by the terrestrial mobile community, the focus by the vast majority of administrations is certainly not on the entire 3.7-4.2 GHz band.

Indeed, most of the initiatives cited by terrestrial parties involve spectrum below 3.7 GHz. T-Mobile, for example, identifies China, Japan, Singapore, Hong Kong, and India as countries that have "begun work to make 3 GHz band spectrum available for 5G," but in footnotes discloses that only Japan is considering frequencies above 3.7 GHz – China is reviewing 3.3-3.6 GHz, Singapore is considering 3.4-3.6 GHz, Hong Kong intends to seek comment on 3.4-3.7 GHz, South Korea is planning an auction of 3.4-3.7 GHz, and India is proposing auctions in the 3.3-3.4 GHz and 3.4-3.6 GHz bands.[142] Thus, only a few countries are considering making any spectrum above 3.7 GHz available for mobile services.

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[141] *See, e.g.*, Comments of Huawei Technologies Co., Ltd., GN Docket No. 17-183, filed Oct. 2, 2017, at 8-9; Ericsson Comments at 5; Nokia Comments at 5; T-Mobile Comments at 7-9; Verizon Comments at 2.

[142] T-Mobile Comments at 8 & nn.29-34.

Given this very limited interest in any frequencies above 3.7 GHz, Verizon's claim that the 3.7-4.2 GHz band "likely will be harmonized for next generation terrestrial mobile services throughout much of the world"[143] is speculation. Moreover, Verizon and others ignore the fact that the 3.7-4.2 GHz band is already globally allocated and harmonized to provide C-band FSS downlinks. As a result, the benefits of harmonization – including economies of scale and equipment commonality – are present today and enhance the value of C-band FSS services for customers in the U.S. and around the globe. Efforts to make the 3.7-4.2 GHz band available for mobile services could undermine these benefits by creating a threat of unacceptable interference to C-band FSS networks.

V. NO SOLUTION HAS BEEN PRESENTED THAT WOULD PREVENT INTERFERENCE TO SATELLITE OPERATIONS IF UNLICENSED DEVICES ARE PERMITTED IN C-BAND UPLINK FREQUENCIES

The SIA Comments note that the prospects for sharing the conventional C-band uplink spectrum and adjacent 6.425-7.125 GHz band are potentially more promising provided the Commission can devise an approach that limits aggregate interference at the satellite receiver.[144] But SIA also highlights the significant challenges associated with managing aggregate interference, especially if unlicensed devices are permitted in these bands. For example, although limiting unlicensed devices to indoor operations would help reduce power levels that could create unacceptable aggregate interference, no method for enforcing such a limitation has been identified.[145] Similarly, the Commission would have to grapple with the limits on its

[143] Verizon Comments at 2.

[144] SIA Comments at 41-42.

[145] *Id.* at 43.

enforcement tools and the possibility that users could alter unlicensed devices to circumvent restrictions designed to constrain aggregate interference.[146]

The record contains almost no discussion of aggregate interference to satellites, and no party suggests a reliable approach to managing these issues. Google, while acknowledging the potential for unacceptable aggregate interference to space station receivers, suggests that it can be managed by using an "automated authorization framework" that would "keep records of satellite beam patterns and ensure that the maximum permissible number of devices is not exceeded within the satellite footprint."[147] But Google does not explain how this proposal would work in practice. For example, how would the location of user devices be known in order to permit a determination of the number of devices that are within a specific satellite's footprint? Also, how would the limit on the number of devices within a satellite's footprint be enforced?

If the Commission is to further consider permitting unlicensed terrestrial operations in C-band uplink spectrum, it must answer these questions and develop a clear and enforceable framework to protect space station receivers from unacceptable interference. Further, it must be recognized that FSS operators and their customers will need to deploy additional transmit earth stations as their needs or requirements change.

[146] *Id.* at 43-44; *see also* Sirius XM Comments at 10 ("if aggregate interference from large numbers of unlicensed consumer devices becomes a problem, the Commission would have few options to remedy the situation").

[147] Google Comments at 14.

VI. CONCLUSION

For these reasons and those set forth in the SIA Comments, the Commission must ensure that essential satellite uses of C-band spectrum are protected and ongoing FSS access to these bands is preserved so that satellite industry members can continue to offer services that promote the public interest, enhance national security, and provide significant economic value.

Respectfully submitted,

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